



Division of Agricultural Sciences
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CERATOCYSTIS CANKER

of
PRUNES
ALMONDS
and
APRICOTS

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A marked increase in the number of scaffold and trunk cankers in prunes, almonds and apricots has been noted throughout California in recent years. The problem has become so severe that it is being studied in detail by plant pathologists J. E. DeVay, F. L. Lukezic, and W. H. English at the University of California, Davis.

These cankers are diseased areas on branches or trunks involving the breakdown and death of affected tissues. In many cases the cankers develop and subsequently enlarge in orchards where prunes, almonds, or apricots have been mechanically injured through cultivation, mallet wounds, or the use of mechanical harvesting equipment. Recently, two mechanically harvested 35-50 acre prune orchards in Sutter County were found to be from 74 to 87 per cent infected with cankers caused by *Ceratocystis fimbriata*, a fungus organism. Trees in these orchards ranged from 10 to 15 years of age.

Usually, only a small percentage of the trees damaged by harvesting and cultivation equipment become infected with *Ceratocystis* during the first year. However, this can be a start for more *Ceratocystis* cankers as, in following years, the fungus increases and spreads from repeated mechanical injuries to bark tissues. Thus, over a three- or four-year period the disease may build up to the point where a *majority* of the trees have *Ceratocystis* cankers—as in the case of the two Sutter County prune orchards.

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THE COVER PHOTO shows a Texas variety almond tree nearly destroyed by cankers made by mallet wounds. Severe pruning back of dead scaffold limbs to new wood helped reclaim the tree.

Photo at right shows (arrow) large canker originating at a bruise on the trunk inflicted by cultural equipment striking the tree.





This injured branch of French prune had begun to heal until infected by fungus which has spread into the healthy tissue above and below the wound (arrows). Such branches are usually girdled and killed within three years.

RELATIONSHIP between mechanical injury and cankers

Mallets (as well as mechanical shakers) cause a certain amount of bark and wood injury, including a crushing and splitting of the bark tissues, apparently creating ideal conditions for the entry of the Ceratocystis fungus.

In prunes there is a direct relationship between the use of mechanical shakers which bruise the bark and the development of Ceratocystis cankers.

In almonds, particularly the Texas (Mission) variety, the disease is associated with injuries sustained at harvest time when mallets or clubs are used to knock the almonds off the trees.

In apricots the occurrence of bruises in limbs is less common, as this crop is not yet harvested mechanically to any extent. Thus Ceratocystis cankers are not

as prevalent as in prunes or almonds.

In all three crops mechanical injury to trunks or scaffold limbs resulting from contacts with cultivation equipment, tractors, etc., has resulted in the development of Ceratocystis cankers. Thus, in addition to the mechanical damage to trunks and limbs, there can be a much greater loss—often involving entire trees or even orchards—as a result of canker-causing fungi entering through injuries.

The discovery of this serious canker disease in prunes occurring in the wake of mechanical harvesting appears to be a setback for mechanization of the harvest equipment. However, future improvements in design and operation are expected to overcome the injurious effects of most shakers.

DESCRIPTION and characteristics of *ceratocystis* cankers

The Ceratocystis fungus enters through cracks in the crushed bark and colonizes the tissues. From this entry point it can parasitize other healthy tissues adjacent to the bruise and cause a canker. The diseased bark usually takes on a depressed, water-soaked or darkened appearance and an amber-to-orange colored gum exudes from the margins around the canker. However, with some cankers little or no gumming occurs.

A characteristic red stain is usually present in the diseased tissues of prunes, in contrast to the dark brown discoloration found in infected tissues on cankered almond and apricot trees. In all cankers a brownish-black stain extends in advance of the fungus infection and permeates deep into the heartwood—with streaks often going several feet past the margins of the canker in the bark.

Once the infection has occurred, the fungus spreads rapidly into the healthy tissues around the bruised area. The fungus expansion occurs all year round, but moves fastest in the summer months.

Typical 18-month-old canker resulting from mallet wound on Ne Plus Ultra. Notice gumming and darkened area on bark showing extent of canker.

Cankers eventually girdle and kill infected trunks or limbs. As the disease spreads it may kill the entire tree. It is estimated that limbs 4–6 inches in diameter can be girdled by the fungus in three or four years.

At the present time some California orchards are in very serious condition. Frequently many or all of the scaffold limbs, as well as the main trunk itself, have extensive cankers—usually originating from shaker injuries.

Despite the wide distribution of Ceratocystis fungus in stone fruits, there is as yet no definite evidence of how it moves from tree to tree or from orchard to orchard. Studies are now in progress to find out if wood borers may carry the fungus from diseased limbs to injured limbs on healthy trees.

Continued use of shakers on diseased trees may also help distribute the fungus throughout the orchard. When the shaker head contacts older cankers, fungus spores or mycelial fragments may possibly be picked up and spread to bruised

Mallet wound canker on Texas almond limb showing cross section (left) and diseased wood (lighter color) beneath canker.



bark on healthy limbs where they can start new cankers. The disease is rarely found in orchards where no mechanical shaking has been carried on. An excep-

tion is where other types of bruises or mechanical injuries have provided entry points for the fungus—for example, disk injury.

TREE VARIETIES and locations where the ceratocystis has been noted

In **prunes** this fungus has so far been found in French, Imperial, and Robe de Sergeant varieties. In **almonds** the disease is of major importance in the Texas variety following mallet wound injury, and to a lesser extent in Nonpareil, Peerless, and Ne Plus Ultra varieties. The Drake variety is less susceptible, and cankers on these trees apparently expand more slowly than cankers on other varieties. Actively spreading Ceratocystis

cankers have been found in Royal (Blenheim) **apricots** whose trunks and limbs were bruised by cultivation equipment.

The susceptibility of different kinds and varieties of stone and pome fruits to Ceratocystis is now being studied.

These cankers have been observed throughout California — from Fresno County in the south to Tehama County in the north, and from the central coastal counties to the Sierra foothills.

COMPARISON of ceratocystis canker with other cankers

Bacterial canker

Ceratocystis cankers should not be confused with bacterial canker—also known as bacterial blast and bacterial gummosis. These serious diseases of

stone fruit trees are caused by the bacterial organism *Pseudomonas syringae*.

The Ceratocystis cankers are active all months of the year and usually continue to grow and enlarge year after year. By contrast, bacterial cankers are active only when the trees are dormant and in the early spring months. After bacterial canker has run its course during these few months, it usually becomes permanently inactive.

Another major difference is that bacterial cankers are most frequently found in young trees, whereas the fungus cankers are found in trees of all ages—especially the older ones.

Shaker injury (top arrow) became infected with canker on this French prune. A year later a shaker head contacted lower edge (bottom arrow) increasing the injury and possibly spreading the fungus to other trees.



In almonds there is also a so-called "blast" phase of bacterial canker involving a killing or blasting of both vegetative and blossom buds in the early spring. Apparently the causal bacteria of this canker disease invade the young developing buds during wet, cold weather throughout the winter and spring growing period. In addition to killing the buds, a light tan discoloration and die-back occur in the bark. This phase of the disease can readily be distinguished from Ceratocystis.

Cytospora

Cytospora, another fungus that is prevalent in most California orchards, has been recently recognized as causing a serious dieback in President Plums. This fungus often infects the bark tissues that have been injured by heat or sun. However, in at least one orchard shaker injuries have opened the way for Cytospora to enter and attack French Prunes. Cankers developed which in most respects were similar to those caused by Ceratocystis.

The major difference between Cytospora and Ceratocystis cankers in prunes is the presence in Cytospora of small fungus fruiting bodies called pycnidia. These are revealed by peeling back the outer bark layer (periderm) with a sharp knife. The pycnidia are small gray pustules about 2 mm in diameter out of which spores emerge in tendrils during wet periods. *They usually do not occur where Ceratocystis is the causal fungus.*

While these pycnidia are a sign of the Cytospora fungus, they do not develop until the cankers are well established and the infected bark is dead or dying.

Both Ceratocystis and Cytospora cause cankers in bruised areas on almond limbs and trunks. The symptoms of Cytospora canker on almonds resemble those described above on prunes. One exception is that the tiny spore-forming fruiting bodies called pycnidia appear less frequently in the outer almond bark,

whereas they are commonly found in the diseased prune bark.

Verticillium wilt

This is still another fungus common in almonds. By careful field examination, Verticillium can usually be identified as a separate disease. Infected trees develop a limb and twig dieback in which the leaves turn tan-brown, dry up and die. This disease frequently appears in early to mid-summer after a period of heat. No external cankers or gumming are found in the limbs infected with this disease, but dark brown to black stains are often seen if cuts are made through the vascular section of infected limbs.

Usually only a part of the tree—perhaps one or two branches—may develop the disease at one time. Most frequently attacked are younger trees from one to seven years of age. Occasional young trees may die, but the majority survive. As the trees become older, Verticillium symptoms tend to lessen and disappear.

Apricots, like almonds, are susceptible to Verticillium wilt and the symptoms are similar.

Cytosporina dieback in apricots

With apricots, the Ceratocystis canker disease may readily be confused with still another fungus disorder known as Cytosporina dieback. These two canker diseases are so similar in appearance that it is frequently difficult or impossible to separate them without the use of laboratory methods. But there are some small visual differences to help distinguish them.

First, the Cytosporina dieback fungus appears to enter through pruning wounds—differing in this respect from the Ceratocystis which enters through bruises. Thus, if a canker develops at the site of a bruise, it is probably Ceratocystis, whereas if it is located in a branch near a pruning wound it is most likely Cytosporina. In removing Cytosporina

dieback, the infected limb may not always be cut sufficiently far from the site of the Cytosporina dieback canker to eliminate all of the infected tissue. When this happens, the fungus extends down the limb and continues to develop entirely apart from the original point of entry at the pruning wound. The resulting canker may be virtually indistinguishable from a Ceratocystis canker.

A second difference is that Cytosporina dieback infection results in a brittle wood condition within the inner wood of infected limbs—particularly larger limbs which often break readily under the

weight of fruit or in windstorms. The fruit and leaves on Cytosporina-infected limbs become wilted, discolored, and tend to remain attached until well into late autumn. The leaves on such branches often take on a lighter color, are somewhat cupped in appearance, and become slightly burned around the margins.

In both canker diseases there is profuse gum development around the margins of active cankers—particularly in the spring and summer months. Both diseases are also much more common in the older trees that have reached fruiting age.

CONTROL of ceratocystis canker in almonds, prunes, and apricots

Surgical treatment has in most cases arrested further canker development in almonds. At present there are no proven methods of curing or stopping the spread of Ceratocystis cankers in prunes, though the surgical method looks promising. This method of control is now under study, but more data is needed before it can be recommended for either prunes or apricots.

The following treatments will reduce losses from Ceratocystis cankers:

Cut away diseased bark around margin of cankers

Surgery may be difficult when the cankers are situated in narrow crotches or other inaccessible positions.

Convenient cutting tools to aid in the surgery of these "hard to get at" cankers include: small shingling hatchets, carpenter's draw knives, bark scrapers and wood chisels. Lightweight chain saws are effective where large cankers are involved.

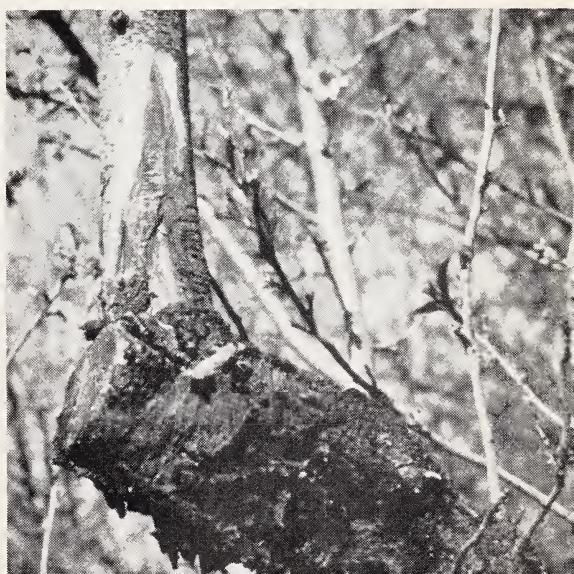
In removing the infected areas, cutting must be extended approximately 1-2 inches beyond the visible margins of the canker in the bark. Cutting away the diseased bark tissues exposes noninfected cambium capable of forming a healthy

callus around the wound. Apparently the exposure of healthy cut surfaces around margins of the canker, and consequent desiccation and dying of the infected areas, may inhibit further growth of the fungus. It has already been noted that Ceratocystis does not enter cuts such as those made around the periphery of a canker, but favors bruised tissues.

Disinfect the exposed areas

Painting the cut-away area of the trunk or bark with a disinfectant such

Failure to prune out all of the canker on this almond tree resulted in infection of new wood. Note cut-away showing extent of canker.



as 0.3 per cent phenol mercury nitrate mixed with 8 parts glycerol and 2 parts lanolin has helped forestall the invasion of the wound by other organisms. Almond nuts from trees treated with this mercurial disinfectant have been analyzed by the Pesticide Residue Research Laboratory on the Davis campus and no mercury residues have been found. Data is now being obtained on its use with prunes and apricots. However, this data has not as yet definitely shown a zero mercurial content. Also, further trials must be conducted to test the efficiency of this treatment.

It must be noted that this mercurial preparation has not as yet been registered by California or federal agencies for use on almond trees, so a definite recommendation cannot be made at this time. The use of Bordeaux paste has been unsatisfactory for treatment of these wounds due to its toxic effect on the tree.

Completely remove badly diseased limbs

Removal of diseased branches and even scaffold limbs is another control measure. Removal is always necessary when a limb has been completely girdled by cankers. Where cankers have already moved into a crotch and invaded a

second limb, the successful cutting away or surgery of cankered areas may be difficult or even impossible. Limb removal is again advisable in this situation, provided there are sufficient healthy limbs remaining to justify saving the tree. It is essential that cankers be detected early and removed before the disease has advanced too far.

In removing limbs, the cuts should be at least 4-5 inches below the visible bark margins of the canker. Inspection of the pruning cut may show an internal wood stain that has progressed down the limb beyond the portion removed. Apparently this internal wood stain is associated with *Ceratocystis*, often advancing ahead of the fungus. Cankered limbs may be removed with the assurance that such inner stains remaining at the site of the pruning will not contain the pathogen.

Branches and prunings removed from the tree should be *immediately* burned, as insects such as borers may aid in carrying the fungus from tree to tree.

Prevention is the best cure

Extreme care in the use of mechanical harvesting and cultivation equipment can reduce bruising and bark injury, thus lessening the possibility of fungus invasion.

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